

Row 1, Extraction

- CBM
 - Water quality
 - Sodium bicarbonate
 - Injection current solution
 - Water quality impact on aquifer
 - Issue of assurance to surrounding landowners vis a vis water quality/availability
 - Ownership of produced/treated waters
- Water quality
 - Uranium—different from others
- Public perception
 - Affecting quality of life
- Impacts of surface mining on aquifer
 - Groundwater recharge
 - Mine drainage
 - Reclamation/vegetation
- Produced water issues (near and long term issue) (2 votes)
 - Ownership
 - Water quality
 - Inconsistency from state to state—institutional, legal
 - Who owns it?
 - Increasing water scarcity
 - 25 year horizon?
- Aquifer impacts (3 votes)
 - Data/aquifer characterization limited information
 - Funding limitations for data acquisition/modeling
 - Groundwater/surface water regulatory cost
 - Community perception/concern
- Water quality (4 votes)
 - Acid mine drainage
 - Injection
 - Public perception
- Cumulative impact of many producers (1 vote)
 - Quantity/quality
- Produced water
 - Not of value/beneficial
 - Need regulations that match water quality with end use (appropriate levels of treatment)
 - Clarify ownership of produced water
 - Need for legal/regulatory reform to promote maximum beneficial use

Row 2, Fuel Production

- Oil shale

- Uncertainty if development will occur
 - If development occurs—large water demand in arid region
- Coal gasification
 - If development occurs—large water demand
- Clean coal
 - Water implications

Row 3, Electricity Production

- Hydro
 - Decommissioning of facilities
 - Instream values
 - Climate change leads to amount of power and shift in timing of production
 - Large opportunity for distributed <5MW systems—licensing/permitting costs disproportionate to project cost (3 votes)
 - Transmission issues
 - Will grid accept?
 - Regional trend toward reduction in hydro output
 - Lack of water management systems (1 vote)
 - Data to optimize/maximize operation of system between major users
 - Uncertainty of forecasting (2 votes)
 - Endangered species act (2 votes)
 - Effect on in-stream flows
 - Hydro water rights
 - Adjudicated
 - Shortages
 - Aging infrastructure (4 votes)
 - Change in mission—\$ required for rehabilitation
 - Climate variability leads to increased cost of catastrophic failure
- Thermal
 - Siting of new facilities
 - Real water impacts
 - Public perception of water impacts
 - Lack of available information in understandable format hinders public debate
 - Recover of cooling water (1 vote)
 - Funding and technology limitations

Row 4, Renewables

- Bio-based (2 votes)
 - Energy/water balance uncertainty
- Geothermal
 - Same as extraction
 - Quantify water resource needs

Row 5, Energy, Other

- Planning horizon currently too short (1 vote)
- Value of water (4 votes)
 - Opportunity/true cost
 - Temporal nature
 - Peak pricing
 - Spatial issue
- Water intensity of energy generation technologies
- Water quality and water transfers
 - NPDES impacts
- Lack of environmental accounting methods to allow comparative analysis between various technologies (7 votes)
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Urban/Ag/Ind

- Pricing (5 votes)
 - Lack of price signals for all water users
 - Regulatory bodies reluctance to adopt more “draconian” rates

Conservation

- Not enough attention on conservation (3 votes)
- Value of conserved water (1 vote)
- Link to infrastructure
 - Transmission velocity of sewage
- Lack of analytic methodology to recognize sequential savings (1 vote)
- Recognition of potential for energy savings WNTF
- Demand hardenings as a by product of lack of buffer (1 vote)

Water conservation-WaterStar

- Savings by design
- Water duty
- Full definition of the value of water saved
 - Determine and quantify the value
 - Better water efficiency metrics
- Incentives/subsidies for recycled water
 - Ex: treated wastewater to ocean
- Severance tax on water lost to ocean

Row 6, Urban Uses

- Need for regional planning/coordination/implementation wrt land use/water (6 votes)
- Political pressure to accept short-term gain vs long-term cost (1 vote)
- Linkage between tertiary treatment and energy cost
- Water quality regulations become stiffer leading to increased energy intensity, often elsewhere (1 vote)
- Projected lack of physical supply—especially in areas of growth (1 vote)
- Water supply (3 votes)
 - Growth management/increasing
 - Energy cost for extraction/increasing
 - Scarcity
 - Limited legal/regulatory (1 vote)\
 - Lack of sustainable viewpoint on aquifer management
 - Lack of view of connection between ground and surface waters
 - Jurisdictional aspect
 - Water treatment
 - Water utility fragmentation
- Transfer laws—lack of efficient system for water reallocation (to recognize new uses) (3 votes)
- Effect of climate change on urban demand—earlier spring/late fall (1 vote)

- High evap rates on reservoirs
- Storage dynamics—future energy demands
 - Snowpack
 - Aquifer
- Infrastructure—aging (2 votes)
 - Original design requirements (ag and power) not necessarily relevant today
- Post 9-11 infrastructure vulnerability are readily exposed
- System leakage (1 vote)

Row 7, Agricultural Uses

- Energy costs associated with irrigation/water delivery leads to change in crop type
 - Surface and groundwater
- Increase in water costs leads to decrease in ag production leads to socio-economic disruption (2 votes)
- Understanding of water balance issues (1 vote)
 - Diversion vs consumptive use
 - How much water is available from increased efficiency?
- Value of water tied to ability to move water
- Substitution of capital for labor
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Rows 8 and 9, Electricity and Energy Production Uses

Row 10, Recreational

- Continual/increased demand for recreational/environmental attribute recognition (1 vote)
- Effluent discharge to river vs potable supply
- Senior water rights vs in-stream flows

Row 11, Environmental

Crosscutting Energy and Water Problems

- Value of water
 - Match water rights with hydrographs to allow hydrograph correlation to better define water rights
 - Reliability for specific water rights; rights index
- Long term value of water
 - Predictive model
- Need accessible database
- Need standard protocol for water rights index
- Quantified federal/tribal reserved rights
- Quantify regulatory (esp ESA, CWA)
- Real time—Australian example
- Environmental accounting methodologies
 - Need better std DSS for full cost env acctg with risk analysis
 - Capture value
- Data needed
 - Water intensity of power production
 - Extraction
 - Production use, etc.
 - Heat rate comparison
 - Gal/kWh
 - Gal/ton CO₂
 - Energy intensity of water uses (kWh/gal)
 - Quality impacts
 - Risk analysis
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Priority Energy Problems

- E1—Lack of environmental accounting methods to allow comparative analysis of various water and energy technologies
- E2—Water produced from energy extraction is not used beneficially

Priority Energy/Water Problem

- E/W3—Current dependence on centralized energy/water/wastewater generation may be unsustainable and needs to be complemented by distributed generation

Priority Water Problems

- W1—Lack of information or understanding of the value of water in terms of true cost, opportunity cost, and spatial and temporal variation in value
- W2—Lack of regional (watershed) planning, coordination, implementation and management across jurisdictions and ownerships to integrate land use and water supply
- W4—Failure to pay attention to water conservation (supply curves of water)

Priority Problem: E1— Lack of environmental accounting methods to allow comparative analysis of various water and energy technologies

- NEED: Better standardized methodologies for decision support systems to capture the full value of water
 - Metrics/data needs
 - Energy/water intensity
 - Gal/kWh
 - kWh/gal
 - gal/ton CO₂
- SOLN: Develop standardized methodologies for decision support systems to capture full environmental accounting
 - Look at standard setting organizations such as NBII, ASTM, NCWR, ASHRAE, IEEE
 - Include broad spectrum of stakeholders
 - Steering committee to direct lab actions
 - Educational function/outreach to various college programs
- SOLN: Develop methods to include water intensity in energy planning/decision making and energy planning in water planning/decision making

Priority Problem: E2—Water produced from energy extraction is not used beneficially

- NEED: Regulations that match water quality with end use
- NEED: Legal/regulatory reform to promote maximum beneficial use
- NEED: Clarify ownership of produced waters
- NEED: Identify markets for degraded/produced water
 - Quality
 - Quantity
 - Duration

- Location
- NEED: Reduce treatment costs for treatment of produced water
 - Prefiltration cost reduction for R/O
 - Improved membrane efficiency
- NEED: Pilot programs to test water reuse

Priority Problem: E/W3—Current dependence on centralized energy/water/wastewater generation may be unsustainable and needs to be complemented by distributed generation

- Aging infrastructure (embedded)/DG
- Asset management
- Condition of asset
- Current needs
- Project future need
 - Compare alternatives included water
- Gap analysis
- Include water in DG
 - Strategic value analysis on a regional basis
 - Refine methodology

Priority Problem: W1—Lack of information or understanding of the value of water in terms of true cost, opportunity cost, and spatial and temporal variation in value

- NEED: Reliability index for specific water rights
 - Need standardized protocol
- NEED: Predictive model for long-term value of water
- NEED: Quantified federal/tribal reserved rights
- NEED: Quantify regulatory (e.g., ESA, CWA)
- NEED: Real-time monitoring data
- SOLN: Develop standards/methodologies for water appraisal
 - Resource economists, borrow from real estate appraisers
- SOLN: Develop standardized protocols for an index of reliability
 - % of time water right is available based on seniority
 - Availability (when) over time
 - Quantity over time
 - Opportunity cost
 - Hydrologists/water rights experts/biologists
 - Anyone who wants to buy water
- SOLN: Database development
 - What is required for index
 - Need real-time flow monitoring system

Priority Problem: W2—Lack of regional (watershed) planning, coordination, implementation and management across jurisdictions and ownerships to integrate land use and water supply

- NEED: Define scale of hydrographic neighborhoods
- NEED: Analytical tools that incorporate water/land
 - Model to integrate land and water
 - Tucson example:
 - Demand forecast
 - Need for uniform standards (WWT return flows, pop forecasts)
- NEED: Gauging systems
 - Integrated measurement and monitoring system
- NEED: Data standards to inform water planning
- NEED: New technologies for measuring/monitoring
 - Gauging station currently \$50k capital/\$15k operate
- NEED: Provide more pervasive monitoring
 - USGS role
- NEED: Develop common data standards for integrated land, land use and water supply planning and management
 - New middleware
 - Data mapping
- NEED: Develop protocols for integrated land, water, wastewater

Priority Problem: W4—Failure to pay attention to water conservation (supply curves of water)

- NEED: Full definition of the value of water saved
 - Determine and quantify value
 - Better water efficiency metrics
- NEED: Incentives/subsidies for recycled water (Ex: treated water to ocean)
- NEED: Severance tax on water “lost” to ocean
- SOLN: Replace aging water meters
- SOLN: Develop incentives for water recycling
- SOLN: Demonstration projects
- SOLN: DOE/WERF/ASSARF/WateReuse/EPA/USGS actors